



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/696,244	10/28/2003	Ivo Raaijmakers	ASMMC.045AUS	7038
20995	7590	07/08/2005	EXAMINER	
KNOBBE MARTENS OLSON & BEAR LLP 2040 MAIN STREET FOURTEENTH FLOOR IRVINE, CA 92614			LEE, HSIEN MING	
			ART UNIT	PAPER NUMBER
			2823	

DATE MAILED: 07/08/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/696,244	RAAIJMAKERS ET AL.	
	Examiner	Art Unit	
	Hsien-ming Lee	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 02 May 2005.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-18 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 4-18 is/are allowed.
- 6) ☒ Claim(s) 1 is/are rejected.
- 7) ☒ Claim(s) 2 and 3 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

HSIEN-MING LEE
PRIMARY EXAMINER

Lee
7/6/05

Attachment(s)

- | | |
|--|--|
| <p>1) <input type="checkbox"/> Notice of References Cited (PTO-892)</p> <p>2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)</p> <p>3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>052905 & 122203</u></p> | <p>4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____</p> <p>5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)</p> <p>6) <input type="checkbox"/> Other: _____</p> |
|--|--|

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claim 1 is rejected under 35 U.S.C. 102(a) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Chen et al. ("THE EFFECT OF SURFACE OXIDES ON Cu/Ta INTERFACIAL INTERACTIONS", submitted by applicants.)

Chen et al. teach a method for manufacturing a semiconductor device, the method comprising, in sequence, the steps of:

- providing a semiconductor substrate, the substrate comprising a first film (i.e. Ta) being a metal film, the first film being exposed at least part of the surface area of said substrate;
- exposing the substrate of Ta to an oxygen-containing reactant (i.e. oxygen, see page 288, third paragraph) to create a surface termination of about one monolayer of oxygen-containing groups (i.e. to form a monolayer-thick surface oxide, see page 288, third paragraph) on the exposed parts of the first film (Ta); and
- depositing a second film (i.e. Cu) onto the substrate, being the other of a diffusion barrier film such that the oxygen-containing groups (i.e. the monolayer-thick surface oxide) form a bridge (i.e. a wetting interface) between the first film and the second film.

Although Chen et al do not use the same claimed terminology, i.e. a bridge between the first film and the second film, one of the ordinary skill in the art would have readily recognized that the wetting function of the surface oxide, as a result of exposing the Ta film to the oxygen at room temperature, would act as the bridge between the first film (i.e. Ta) and the second film (i.e. Cu film), in particular, a small amount of oxygen exposure leading to chemisorbed atomic oxygen and forming the monolayer-thick surface oxide (see third paragraph, page 288).

3. Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Raaijmakers et al. (US 6,727,169).

In re claim 1, Raaijmakers et al. teach a method for manufacturing a semiconductor device, the method comprising, in sequence, the steps of:

- providing a semiconductor substrate, the substrate comprising a first film being a metal film 52 (i.e. Cu, see Fig.9A and col. 6, lines 7-8), the first film 52 being exposed at least at part of the surface area of said substrate;
- exposing the substrate to an oxygen-containing reactant (i.e. a metal-containing species comprising oxygen, i.e. tantalum pentaethoxide or $\text{Ta}(\text{OC}_2\text{H}_5)_5$, see col. 8, lines 56-63, step 104 in Fig.3 and col. 11, lines 13-16) to create a *surface termination* of about one *monolayer* of oxygen-containing groups (col. 12, lines 33-37 and col. 19, lines 41-43) on the exposed parts of the first film 52; and
- depositing a second film 150 (i.e. an adhesion layer, see Fig.10) onto the substrate, being other of a diffusion barrier and a metal film (col. 10, lines 42-44 and 53-58).

Although Raaijmakers et al. do not literally use the same claimed terminology, i.e. a bridge between the first film and the second film, Raaijmakers et al. suggest that as result of

exposing the first film 52 to the oxygen-containing reactant, the oxygen-containing reactant would chemisorb at the exposed surface of the first film (col. 12, lines 32-37 and col. 8, lines 62-63). Therefore, one of the ordinary skill in the art would have readily recognized that the monolayer-thick layer that is chemisorbed upon the exposed surface of the first film 52 would act as the bridge between the first film 52 and the second film 150, since the monolayer-thick layer is used to promote the adhesion between the first film and the second film (col. 11, lines 7-12).

Allowable Subject Matter

4. Claims 4-18 are allowed.
5. Claims 2-3 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.
6. The following is a statement of reasons for the indication of allowable subject matter:

Raaijmakers et al. teach the related method, as stated previously, In contrast, Raaijmakers et al. at least neither teach nor suggest exposing a substrate to an oxygen-containing reactant to create a surface termination of about one monolayer of oxygen-containing groups *on diffusion barrier*; a monolayer of oxygen atoms at the interface *between the diffusion barrier and the metal film*; and a metal oxide bridge material sandwiched *between the diffusion barrier and the metal conductor*.

Conclusion

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-ming Lee whose telephone number is 571-272-1863. The examiner can normally be reached on Tuesday-Thursday (8:00 ~ 6:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Art Unit: 2823

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Hsien-ming Lee
Primary Examiner
Art Unit 2823

July 6, 2005

HSIEN-MING LEE
PRIMARY EXAMINER

7/6/2005